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THE CLIMATE OF THE OTWAY REGION

By D. J. Linforth

INTRODUCTION

The Otway Region for this meteorological survey is defined as the area south of the Princes Highway and extending from Warrnambool to Torquay. Most of the area is hilly, with the main Otway Ranges reaching an elevation of 600 metres.

METEOROLOGICAL DATA

Daily rainfall records for at least 30 years are available for 47 stations in the area, while records extend beyond 50 years at 34 of these. There are currently four pluviographs in the area, but only two of them have records for more than two years.

Observations of temperature, humidity and cloud are available for eight stations, four at towns on the Princes Highway, two on the coast and two in the northern foothills of the Otway Ranges. There are no records of these elements on the high country. At some of these stations observations have not been made on all seven days of the week.

Wind observations are made at these eight stations, but at only two is there an instrument; at the others wind speed is estimated by the observer.

METEOROLOGICAL CONTROLS

The general weather of southeastern Australia is determined primarily by the behaviour of pressure systems, which move from west to east on a more or less latitudinal track. The mean track of anticyclones is centred south of the continent from November to April but is located between latitude 30°S and 35°S from May to October.

Anticyclones are separated by low pressure areas, which usually contain active frontal surfaces separating air masses of different characteristics. These low pressure areas are rain bearing systems and have most influence in winter and spring. Rainfall in the Otway Region is frequent and often heavy in these seasons.

In summer, the southern location of the anticyclonic belt brings an easterly wind flow over the district. When anticyclones move into the Tasman Sea, where they sometimes stagnate for several days, winds tend northerly. This situation results in heatwave conditions which persist until relieved by the west to southwest winds associated with the next oncoming depression. At places on the coast, however, the heat is tempered by sea breezes except on the last day of a heatwave when the northerly wind is usually strongest.

The Otways are usually beyond the reach of moist air of tropical origin, which, in summer, can be responsible for heavy rain over eastern and northern Victoria. Occasionally, however, warm moist air from the Tasman Sea penetrates far enough westward over the colder waters of Bass Strait to produce sea fog off the Otway coast.

The climate of the Otway Region follows, in a general way, a pattern which has been described as Mediterranean, i.e. hot dry summers and cool wet winters.

RAINFALL

The effect of elevation on rainfall is very marked in this Region, and can be seen in Figs. 1-3. The wettest part is along the main ridge of the Otway Ranges, where the average annual rainfall is in excess of 1800 mm. This ranks among the wettest areas in Victoria. To the northeast of the Region is a marked rain shadow, which extends over much of the inland plains of the Western District. Northeast of Winchelsea-Torquay, the average annual rainfall is less than 600 mm.

Average rainfall in January and July is shown in Figs. 2 and 3 respectively. These show the markedly seasonal nature of the rainfall, rainfall in July being about 2½ times that in January. On the average, about 60% to 65% of the rain falls in the May-October period.

The rainfall is very reliable, the coefficient of variation (standard deviation of the annual rainfall divided by the average annual rainfall) for the West Coast rainfall district is 0.16, which with West Gippsland, is the lowest in Victoria.

Although the average summer rainfall is much lower than in winter, heavy rain can fall in summer, on rare

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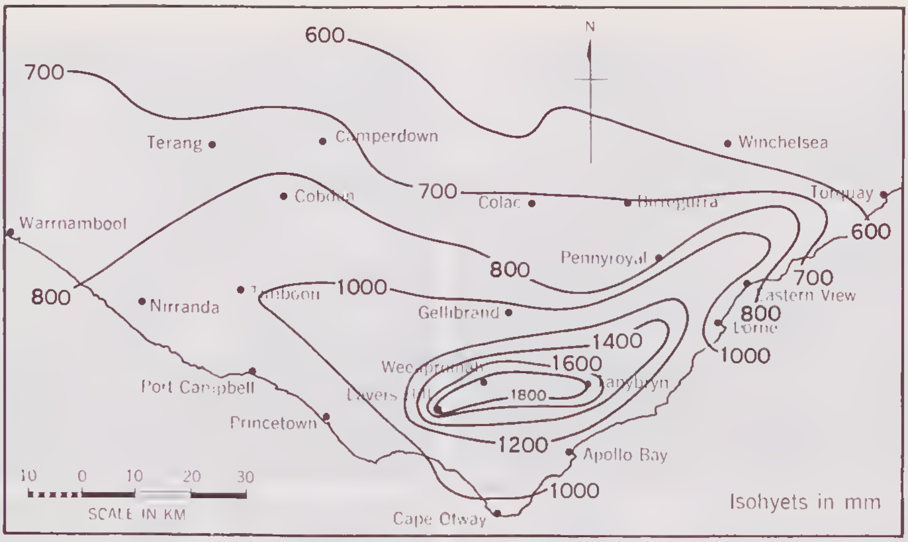


FIG. 1—Average Annual Rainfall.

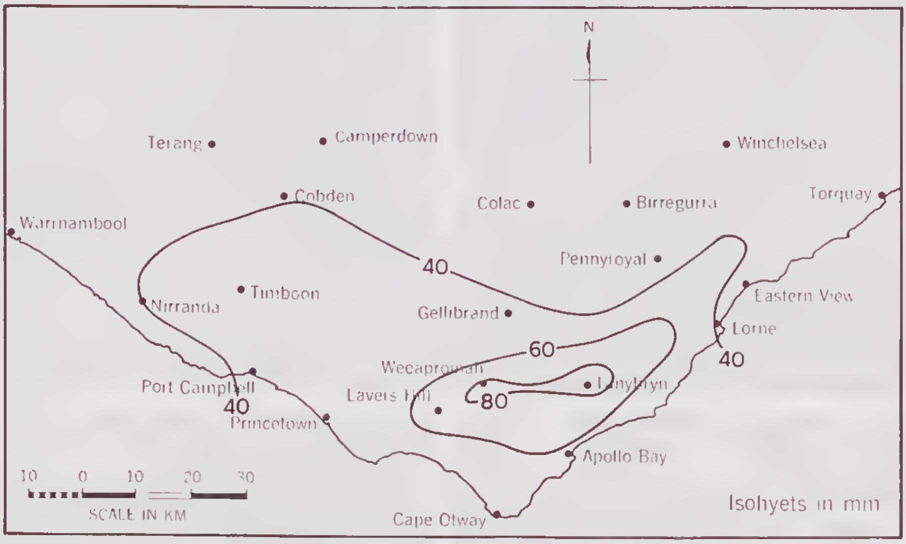


FIG. 2—Average Rainfall—January.

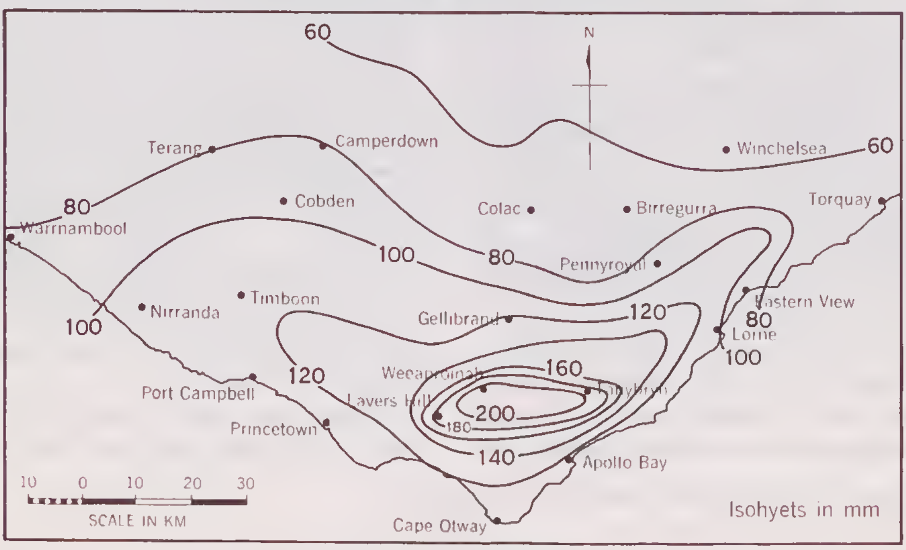


FIG. 3—Average Rainfall—July.

TABLE 1
HIGHEST RAINFALL ON RECORD FOR 1, 2 AND 3 DAYS

Station	1 Day Rain-fall (mm)	Month of Occurrence	2 Day Rain-fall (mm)	Month of Occurrence	3 Day Rain-fall (mm)	Month of Occurrence
Birregurra	86	Feb.73	98	Dec.33	104	Dec.33
Winchelsea	101	Feb.73	135	Dec.33	142	Dec.33
Colac	103	Feb.73	123	Feb.46	124	Feb.46
Eastern View	170	Feb.54	200	Dec.33	204	Dec.33
Lorne	180	Feb.54	231	Dec.33	238	Dec.33
Pennyroyal Ck.	123	Jun.52	220	Jun.52	242	Jun.52
Tanybryn	233	Jun.52	461	Jun.52	587	Jun.52
Weeaproinah	154	Mar.19	244	Apr.60	270	Apr.60
Cape Otway	93	Mar.32	134	Mar.32	145	Mar.32
Apollo Bay	*	-	281	Mar.32	305	Mar.32
Port Campbell	114	Jan.52	118	Mar.32	125	Mar.32
Princeton	102	Jan.52	145	Mar.32	150	Mar.32
Nirranda	118	Mar.46	148	Mar.46	157	Mar.46
Warrnambool	167	Mar.46	217	Mar.46	229	Mar.46
Terang	90	Jan.37	118	Feb.46	126	Mar.10
Cobden	90	Feb.57	102	Feb.57	129	Feb.11
Camperdown	88	Jan.41	114	Jan.41	121	Jan.41

*Rainfall measured for only 2 days at Easter 1932.

occasions. Table 1 shows the highest one, two and three day falls at a number of stations. It can be seen that most of these high falls have occurred in the warmer months from December to March. The warmer atmosphere at this season can hold more moisture, and when a rain-producing mechanism does occur, heavy rain results.

TEMPERATURE

Monthly temperature data are shown in Table 2. The 14 percentile of maximum temperature is that temperature which is not reached on 14 per cent of days, the 86 percentile is that temperature which is not reached on 86 per cent of days, i.e. which *is* reached on 14 per cent of days. Fourteen per cent of days represents one day in seven. Similarly, temperature falls below the 14 percentile of minimum temperature on 14 per cent of days or remains above the 86 percentile on 14 per cent of days.

Mean maxima are higher inland than on the coast in summer, but the coast has marginally higher maxima in winter. The range of maximum temperature, as shown by the 14 and 86 percentiles is much higher in summer than in winter. The extreme maxima are practically the same at all these lower level places, i.e. on occasions, unusually warm air spreads over the entire Region and sea breezes have no effect. Mean minima are lower inland than on the coast in all seasons, and the extreme minima follow this pattern also.

Data on frost are given in Table 3. Frost is rare right on the coast. The station at Warrnambool is at the Post Office, about 3 km from the open beach, and here light frosts occur on a few days per year, but heavy frosts are rare.

TABLE 2
TEMPERATURE DATA (°C)

Station	Altitude (metres)	Data	No. of Years of Record	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Lorne	15	Mean Max. Temp.	70	23.0	22.8	21.6	19.0	16.1	13.8	13.2	14.4	16.3	18.2	19.9	21.5
		14 percentile	4	18.9	19.8	18.4	17.5	14.0	12.5	12.2	11.9	13.1	15.1	16.5	17.5
		86 percentile	4	25.6	29.6	25.3	23.5	19.4	16.1	16.0	16.7	19.3	21.5	21.7	25.0
		Extreme Temp.	55	43.6	41.7	40.9	31.7	26.1	18.6	21.6	25.1	30.8	38.3	37.8	40.7
		Year of Extreme		1939	1919	1942	1922	1921	1940	1975	1940	1928	1914	1927	1941
		Mean Min. Temp.	70	12.2	12.9	12.0	10.2	8.6	7.0	6.2	6.9	7.2	8.3	9.5	10.9
		14 percentile	4	11.7	12.5	11.5	10.3	7.8	6.2	5.8	5.6	6.1	7.2	8.3	10.0
		86 percentile	4	17.0	18.3	16.4	15.3	12.2	10.7	9.4	9.4	11.2	12.5	12.8	15.0
		Extreme Temp.		4.4	5.0	2.8	0.6	1.5	0.6	-0.6	1.3	0.0	1.7	3.9	4.4
		Year of Extreme		1930	1905	1935	1917	1928	1949	1929	1944	1938	1926	1926	1924
Cape Otway	91	Mean Max. Temp.	106	21.5	21.5	20.4	17.6	15.2	12.5	12.9	13.8	15.2	16.9	18.4	19.6
		14 percentile	17	17.2	17.2	16.4	14.4	12.8	11.7	10.8	11.1	11.7	12.8	13.9	15.6
		86 percentile	17	26.1	27.2	24.4	22.5	17.4	15.6	13.9	15.1	17.4	20.9	22.2	24.4
		Extreme Temp.	68	42.8	40.6	38.9	32.8	25.6	21.7	21.8	23.9	30.0	34.2	38.1	39.2
		Year of Extreme		1908	1919	1934	1958	1921	1957	1975	1940	1928	1914	1921	1920
		Mean Min. Temp.	106	13.1	13.6	13.0	11.5	9.8	8.0	7.3	7.7	8.3	9.5	10.5	11.9
		14 percentile	17	11.1	11.7	10.6	8.9	7.3	6.3	5.6	5.6	5.6	7.1	7.8	9.4
		86 percentile	17	15.6	16.4	15.6	14.0	11.7	10.6	9.3	9.4	10.0	11.7	12.2	14.1
		Extreme Temp.	68	6.1	5.0	4.4	3.3	1.7	1.7	0.0	1.1	1.7	1.1	3.9	4.4
		Year of Extreme		1951	1945	1964	1965	1963	1922	1966	1935	1908	1962	1935	1955
Warrnambool	21	Mean Max. Temp.	77	22.0	22.0	20.9	18.5	15.9	13.8	13.2	13.9	15.6	17.2	18.8	20.5
		14 percentile	17	18.8	18.4	18.0	16.1	13.7	12.5	11.7	12.2	13.3	14.5	15.6	16.8
		86 percentile	17	30.1	29.3	27.7	24.7	18.9	16.7	15.6	17.2	19.4	22.8	25.3	26.1
		Extreme Temp.	78	46.1	43.9	41.7	34.2	30.0	23.1	22.5	23.9	30.6	36.9	39.4	43.3
		Year of Extreme		1908	1901	1934	1958	1905	1957	1975	1911	1928	1914	1921	1897
		Mean Min. Temp.	77	12.7	13.2	12.1	10.3	8.5	6.8	6.1	6.6	7.6	8.9	10.0	11.5
		14 percentile	17	10.0	10.6	9.0	7.2	5.6	2.8	3.0	3.3	5.0	5.7	6.7	8.5
		86 percentile	17	16.1	16.1	15.0	13.3	11.2	9.4	8.3	8.9	10.0	11.7	12.8	14.4
		Extreme Temp.	78	4.4	3.4	3.3	1.1	-1.1	-1.1	-1.9	-1.6	0.3	1.1	1.7	3.2
		Year of Extreme		1919	1949	1907	1942	1910	1949	1960	1966	1908	1939	1965	1949
Terang	132	Mean Max. Temp.	60	24.9	25.2	22.7	18.5	15.3	12.7	12.2	13.2	15.5	17.7	20.1	22.9
		14 percentile	9	18.4	18.9	17.5	15.6	12.8	11.1	10.6	11.1	12.2	13.3	14.4	16.1
		86 percentile	9	33.3	33.3	30.9	25.9	19.4	15.6	14.9	16.1	18.3	23.3	25.6	28.9
		Extreme Temp.	69	45.0	42.8	41.1	33.3	28.3	21.1	20.5	22.2	30.0	35.6	38.9	41.1
		Year of Extreme		1939	1912	1940	1958	1905	1957	1975	1969	1961	1914	1962	1960

TABLE 2 (Continued)

Station	Altitude (metres)	Data	No. of Years of Record	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
		Mean Min.Temp.	60	10.7	11.5	10.3	8.2	6.6	4.7	4.1	4.6	5.8	6.9	8.3	9.6
		14 percentile	9	7.4	8.9	6.7	5.6	3.3	0.9	1.7	2.2	2.8	3.9	5.0	6.7
		86 percentile	9	16.1	17.2	14.4	12.2	10.0	7.3	6.7	7.2	8.3	11.1	11.7	13.0
		Extreme Temp.	61	0.0	1.1	1.1	-0.6	-2.2	-2.8	-2.8	-3.3	-2.2	-1.1	0.6	2.2
		Year of Extreme		1950	1908	1921	1947	1946	1949	1963	1929	1940	1924	1963	1955
Camperdown	165	Mean Max.Temp.	70	26.1	26.0	23,6	18.9	15.4	12.6	12.1	13.7	15.9	18.2	20.4	23.9
		14 percentile	9	20.0	20.1	18.2	15.6	12.8	11.1	10.9	11.1	12.7	14.0	15.1	17.1
		86 percentile	9	34.1	34.2	30.6	25.9	18.9	15.0	14.4	16.1	19.0	24.8	26.0	30.4
		Extreme Temp.	67	45.3	43.3	41.7	34.4	28.9	21.7	21.0	24.4	30.8	37.2	38.0	41.9
		Year of Extreme		1939	1912	1940	1938	1905	1957	1975	1914	1928	1914	1966	1920
		Mean Min.Temp.	70	11.5	12.2	10.9	8.6	6.7	4.7	4.0	4.8	6.1	7.3	8.6	18.3
		14 percentile	9	8.9	9.9	8.2	15.8	4.4	1.8	1.9	2.4	3.4	4.5	6.0	7.2
		86 percentile	9	16.2	17.1	14.4	12.2	9.5	6.8	6.7	7.1	8.9	10.6	11.7	13.3
		Extreme Temp.	67	1.1	0.0	1.7	-1.7	-1.1	-2.2	5.0	-2.8	-1.1	-1.1	-0.6	0.6
		Year of Extreme		1902	1945	1917	1901	1927	1940	1929	1938	1907	1918	1917	1907
Colac	134	Mean Max.Temp.	72	25.6	25.8	23.4	19.8	15.7	13.0	12.3	13.6	15.7	18.1	20.7	23.4
		14 percentile	16	20.0	19.6	18.3	15.0	12.2	11.1	10.0	11.1	12.8	13.9	15.0	16.7
		86 percentile	16	34.4	32.8	29.4	23.9	18.3	15.6	13.9	16.1	18.3	22.8	25.9	30.6
		Extreme Temp.	74	44.4	41.1	41.1	33.3	29.4	21.7	21.2	23.3	29.4	35.6	37.8	41.1
		Year of Extreme		1939	1914	1940	1938	1905	1957	1975	1940	1926	1914	1927	1920
		Mean Min.Temp.	72	10.6	11.1	9.9	7.9	6.1	4.4	3.9	4.4	5.7	6.8	8.2	9.3
		14 percentile	16	3.9	5.0	3.9	1.7	0.6	0	-0.6	0.6	1.1	1.7	3.3	3.3
		86 percentile	16	13.9	13.9	13.9	11.1	8.9	8.3	6.7	7.2	8.3	10.0	11.7	13.3
		Extreme Temp.	74	0.6	0.6	0.0	-3.9	-3.3	-4.4	-5.0	-3.3	-3.9	-3.3	-2.8	-0.6
		Year of Extreme		1957	1931	1965	1963	1957	1965	1960	1963	1959	1967	1967	1967
Gellibrand	84	Mean Max.Temp.	9	24.5	25.4	22.5	19.5	15.3	13.1	12.6	13.6	14.8	17.6	19.5	21.8
		14 percentile	9	18.3	18.9	17.0	15.0	12.6	11.1	10.6	11.1	11.2	13.3	14.4	16.2
		86 percentile	9	31.9	32.9	29.8	24.7	18.9	15.0	14.4	16.1	18.9	23.3	25.4	28.4
		Extreme Temp.	20	43.3	40.6	38.9	31.7	25.1	21.1	20.5	22.2	31.7	29.4	37.2	38.2
		Year of Extreme		1959	1967	1966	1968	1967	1957	1975	1969	1965	1965	1966	1960
		Mean Min.Temp.	9	10.0	10.9	8.8	7.6	5.1	3.0	3.4	3.7	5.0	6.2	7.7	9.0
		14 percentile	9	5.6	6.7	5.0	3.9	1.6	-0.6	0	0	1.6	2.2	4.0	5.4
		86 percentile	9	14.4	15.6	13.0	11.1	9.4	7.2	6.7	6.9	8.5	10.0	11.1	12.8
		Extreme Temp.	20	0.0	1.1	0.0	-2.2	-1.7	-4.4	-6.5	-3.9	-1.7	-3.1	0.0	1.1
		Year of Extreme		1958	1963	1965	1967	1969	1969	1974	1957	1966	1967	1960	1967

TABLE 3(a)
AVERAGE NUMBER OF DAYS OF LIGHT FROST
(temperature ≤ 2.5°C)

Station	No. of Years	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Colac	12	1.5	0.8	1.2	4.8	8.3	10.9	13.2	10.8	8.0	6.1	2.7	2.9	72
Gellibrand	10	0.3	0.1	1.0	2.2	7.6	14.0	10.4	10.8	6.9	4.4	1.1	0.4	55
Warrnambool	10	-	-	-	0.1	0.3	3.3	2.6	1.5	0.2	0.1	0.2	-	8

TABLE 3(b)
AVERAGE NUMBER OF DAYS OF SEVERE FROST
(temperature ≤ 0°C)

Colac	12	-	-	0.2	0.8	3.0	5.3	6.4	4.0	2.9	1.0	0.2	0.2	25
Gellibrand	10	-	-	0.2	0.4	2.1	8.2	5.8	5.7	1.9	1.0	0.1	-	23
Warrnambool	10	-	-	-	-	-	0.4	0.1	0.2	-	-	-	-	0.7

TABLE 3(c)
FIRST AND LAST DATES OF FROST

Station	Years	First Dates				Last Dates			
		Earliest 2.2°C	Median 2.2°C	Earliest 0°C	Median 0°C	Median 0°C	Latest 0°C	Median 2.2°C	Latest 2.2°C
Colac	1957-68	2 Jan.	25 Jan	25 Mar	27 Apr	15 Oct	19 Dec	21 Dec	31 Dec
Gellibrand	1965-74	10 Jan.	5 Apr	25 Mar	15 Apr	15 Sep	26 Oct	22 Nov	8 Dec
Warrnam-bool	1957-74	17 Apr.	1 Jun	6 May	18 Jun	11 Jul	17 Aug	27 Aug	25 Nov

Colac seems to be unusually prone to frost, but this may be due to the observing station over this period of record being in a 'frost hollow'. Frost can be very localized and is more liable to occur in hollows where cold air can accumulate on clear, calm nights.

WIND

Wind shows the seasonal nature arising from the meteorological controls described above.

Fig. 4 comprises wind diagrams for January and July for three stations. The diagrams are compiled from wind observations at 9 a.m. and 3 p.m., isopleths being drawn of frequency of various wind speeds and directions.

At Cape Otway in July the most frequent wind is northwest at 25 km/h, while in January, easterly and westerly winds of 25 km/h are equally frequent. At Warrnambool Post Office southwesterly winds of 12 km/h are most common in January and northwest winds of 5 km/h most common in July.

Strong winds are most frequent on the coast. Cape Otway has a far higher frequency of wind speed over 40 km/h than the inland stations.

PHENOMENA

Fog inland is most common in winter, forming overnight due to radiational cooling of moist air, and dissipating a few hours after sunrise on most occasions. At Colac it occurs on about 20 days per year. Along the coast, fog is more common in summer, when warm moist air from the Tasman Sea is brought over the cooler waters of Bass Strait. At Cape Otway it occurs on about five days per year. The seaward slopes of the Otways may be shrouded in fog while the landward side is enjoying a warm and sunny day.

Thunder is heard on 10 to 14 days per year, about the same frequency as most places in Victoria.

Hail occurs on one or two days per year, mostly

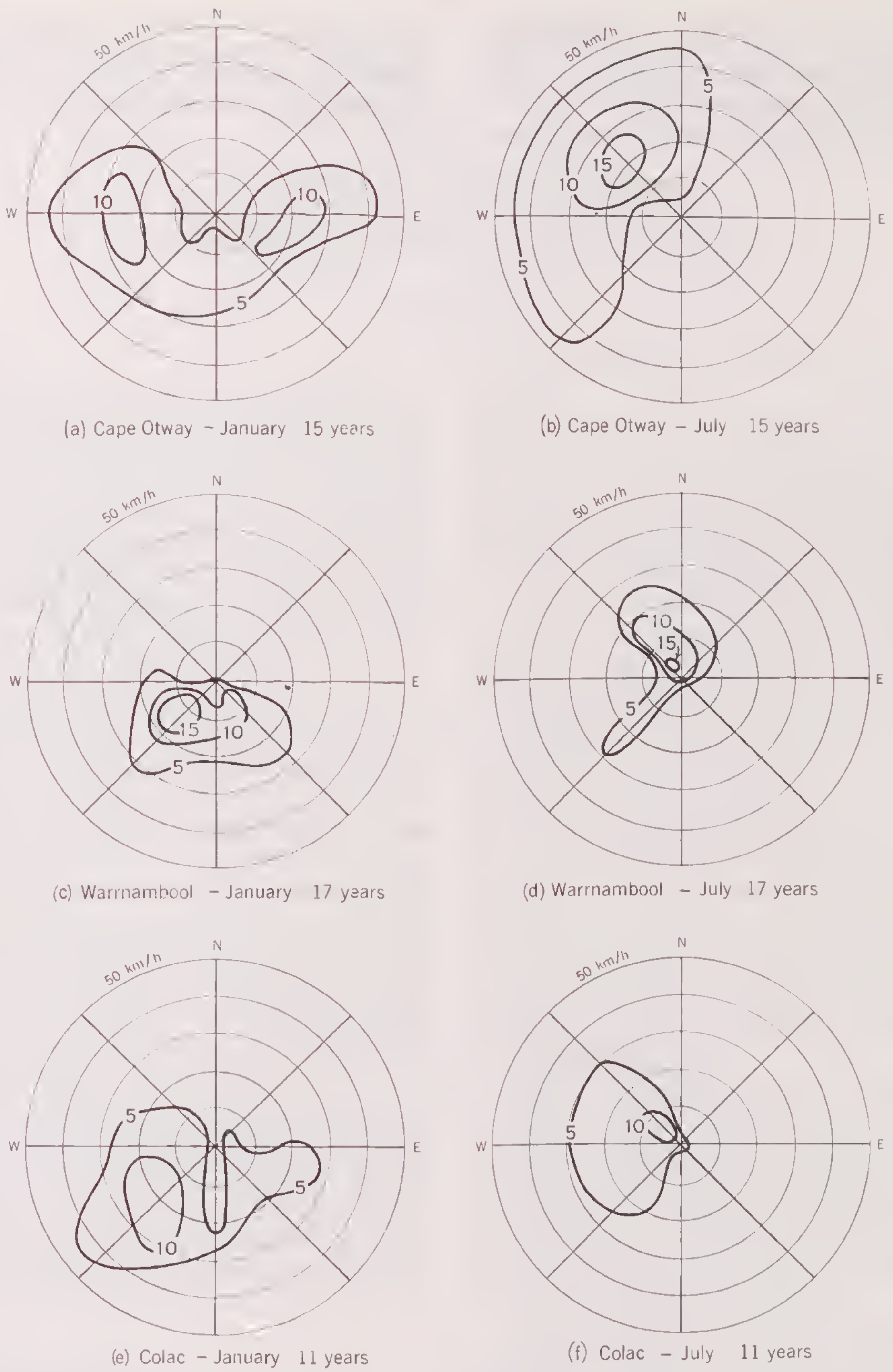


FIG. 4—Relative Frequency of Wind Speed (km/h) and Direction—Daytime Isopleths are percentage frequency of occurence.

during very cold weather in winter. Large and damaging hail tends to be associated with violent thunderstorms, which affect only a small area, and its occurrence at a given spot is very rare.

Snow occurs on the high country on two or three days per year, and has fallen to depths of five to ten centimetres. It is very rare over the lower country, two memorable occasions being 28 July 1901 and 4 August 1943 when most of the Western District was covered in snow.